DWORSHAK DAM IMPACTS ASSESSMENT AND FISHERIES INVESTIGATIONS PROJECT

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DWORSHAK DAM IMPACTS ASSESSMENT AND FISHERIES INVESTIGATIONS PROJECT

ANNUAL PROGRESS REPORT
January to December 1993

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CHAPTER 1

KOKANEE POPULATION STATUS IN DWORSHAK RESERVOIR

ABSTRACT

We monitored the kokanee Oncorhynchus nerka kennerlyi population in Dworshak Reservoir, Idaho, by mid-water trawling and counting spawners in representative streams. Our estimates of age 1 kokanee abundance in 1993 were the highest on record; 556,000 fish. These fish resulted from last years record year class of age 0 kokanee. Age 2 kokanee were also abundant, achieving their second highest level on record. Dworshak Dam discharged less water between July 1, 1992 and June 30, 1993 than any of our recent years of study (the lowest since 1986-1,987). Based on a past relationship with an r^2=0.62, we expected age 2 kokanee abundance to be very high with this low level of discharge.

We estimated mature kokanee abundance by trawling, which correlated well (r^2=.89) to standardized spawner counts. This gives us the means to convert the older spawner count data into age 2 kokanee estimates. It is also a validation of spawner counts in tributary streams as an accurate method to obtain an index of adult kokanee abundance.

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INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program [903(e)(4)] authorized the Bonneville Power Administration to fund studies to assess the impacts of Dworshak Dam operation on reservoir fisheries. Research began in 1987 and was a cooperative effort between the Idaho Department of Fish and Game (IDFG) and the Nez Perce Tribe of Idaho (NPT). IDFG evaluated kokanee Oncorhynchus nerka kennerlyi population dynamics and documented changes in reservoir productivity. The NPT Department of Fisheries Management investigated the status of smallmouth bass Micropterus dolomieu, rainbow trout O. mykiss and their fisheries.

Additional data was collected in 1993 to continue to build on this database and to provide information to the System Operation Review (SOR) being conducted by the U.S. Army Corps of Engineers, the U.S. Bureau of Reclamation, and the Bonneville Power Administration. Data from this report will also be used to evaluate new changes in dam operation and its impact on resident fisheries.

Monthly hydroacoustic surveys of Dworshak Reservoir also began in October of 1993. This data will be reported in the 1994 project report.

GOAL

The goal of this study was to maximize the kokanee fishery in Dworshak Reservoir.

OBJECTIVES

Our objective was to reduce the entrainment mortality of kokanee so that kokanee densities in the reservoir will increase to 30-50 age 2 kokanee/hectare, as measured by trawling.

DESCRIPTION OF STUDY AREA

Dworshak Dam is located on the North Fork of the Clearwater River 3.2 km upstream from its confluence with the mainstem (Figure 1). The dam is about 5.2 km northeast of Orofino in Clearwater County, Idaho. At 219 m high, it is the largest straight-axis concrete dam in the United States. Three turbines within the dam have a total operating capacity of 450 megawatts. Water can be discharged from the reservoir through the turbines, outlet gates, or tainter gates on the spillway.

Dworshak Reservoir is 86.2 km long and has 295 km of mostly steep shoreline. Maximum depth is 194 m with a corresponding volume of 4.28 billion m^3 at full pool. Surface area when full is 6,644 hectares and mean depth is 56-m. It contains 5,396 hectares of kokanee habitat (defined as area over 15.2 m deep). Mean annual outflow is 162 m^3/s. The reservoir has a mean retention time of 10.2 months. Retention time is variable depending on precipitation and has ranged from 22 months in 1973 to 6 months during 1974 (Falter 1982). Drawdowns of 47 m reduce surface area as much as 52% (3,663 hectares). Dworshak Reservoir initially reached full pool on July 3, 1973.

The drawdown regime for Dworshak Reservoir changes annually depending on forecasted snowpack and operating criteria such as water releases for salmon flows. During the summer of 1993, the pool elevation dropped markedly during July and August as water was released for anadromous fish flows (Figure 2). The reservoir was then held stable throughout the fall and winter.

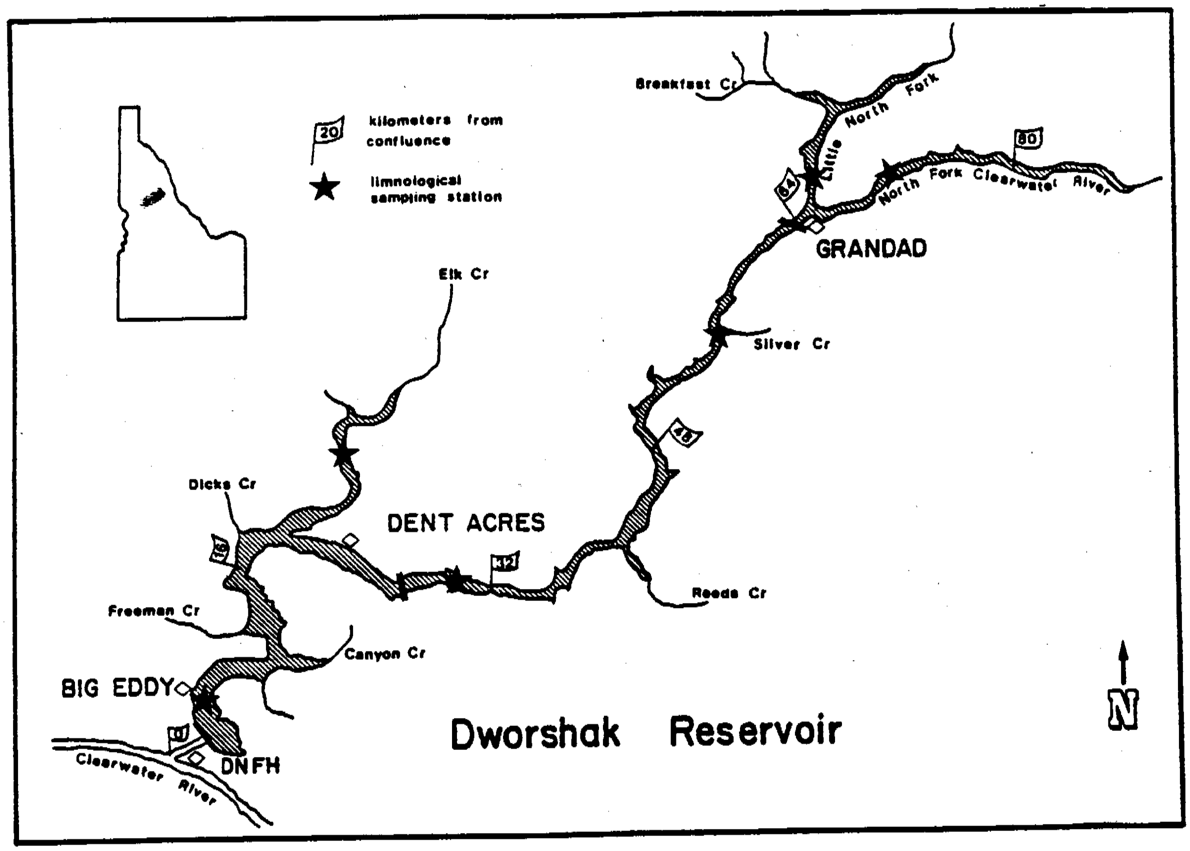

Figure 1. Dworshak Reservoir and major tributaries, North Fork Clearwater River, Idaho. The reservoir was divided into three sections for sampling: Section 1 (dam to Dent Bridge), Section 2 (Dent Bridge to Grandad Bridge), and Section 3 (Grandad Bridge to end of pool).

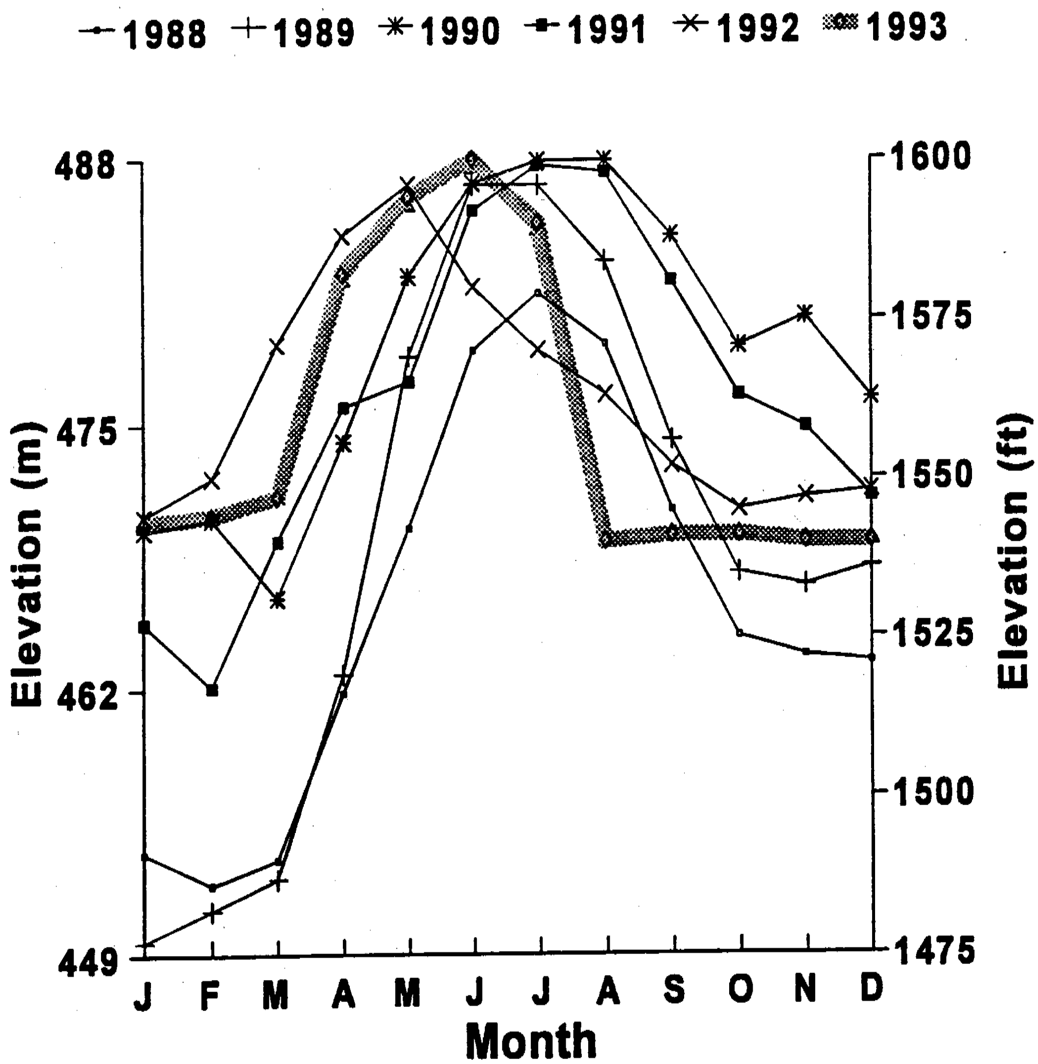

Figure 2. Water surface elevations of Dworshak Reservoir, Idaho, on the 15th day of each month, 1988-1993.

METHODS

Kokanee Abundance

Oblique tows of a mid-water trawl were used to obtain density estimates of kokanee and representative samples of fish for aging. An 8.5-m, 140 horsepower diesel engine boat towed the trawl net, which was 13.7-m long with a 3-m by 3-m mouth. Mesh sizes (stretch measure) graduated from 32-mm to 25-mm to 19-mm to 13-mm in the body of the net and terminated in a 6-mm mesh cod end.

All trawling was conducted after dark during the new moon phase to optimize capture efficiency (Bowler et al. 1979). Net towing speed was standardized at 1.5 m/s. Depth of the net was determined for each 15.2-m distance of tow cable and checked annually. The layer of kokanee distribution was determined using a Raytheon Model V860 depth sounder with a 20 degree transducer. This vertical distribution of kokanee was divided into 3.5-m sublayers; usually 3 to 5 sublayers encompassed the vertical distribution. A step-wise oblique net tow was made through the kokanee layer. The net was pulled for 3 min in each sublayer, sampling 2,832 m^3 of water over a distance of 315-m (at a boat speed of 1.5 m/s). The time it took to readjust the net between sublayers and the time the net was in the kokanee layer while initially setting the net was also entered into density estimates (approximately 30 seconds between sublayers while raising and lowering the net).

A stratified random sampling design was used to choose trawl locations. The reservoir was divided into three sections with the Dent and Grandad bridges serving as boundary lines (Figure 1). Section 1 was the lower end of the reservoir (2,562 hectares of kokanee habitat), section 2 the middle (1,499 hectares of kokanee habitat), and section 3 was the upper reservoir (520 hectares of kokanee habitat). During trawling, the reservoir was at 481-m elevation (1,580 feet) with the mid point of the kokanee layer at about the 20-m depth; therefore kokanee habitat was defined as the area inside the 457-m contour (1,500 feet). Five to seven trawls were made in each section. Reservoir sections were the same each year, but trawl locations were randomized annually. During 1993, trawls were begun at river kilometers 5, 8, 11, 16, 18, 24, 29, 31, 53, 58, 60, 66, 68, 71, and in the Little North Fork Clearwater arm, at river kilometers 2 and 3. Trawl direction was parallel to the long axis of the reservoir due to spacial limitations. Trawling was conducted on the nights of July 19, 20, and 21, 1993.

The number of kokanee of a specific age class collected in each haul was divided by the volume of water sampled to obtain an age specific density estimate. These densities were then multiplied by the thickness of the kokanee layer (in m) at the trawling site and then multiplied by 10,000 to obtain the number of kokanee per hectare at that site. Mean densities in each section were multiplied by the area of that lake section to obtain population estimates and summed to make whole-lake population estimates. Parametric statistics were then applied to the density estimates to calculate 90% confidence limits. Mean kokanee weights in each 10-mm size group were averaged to determine the mean weight of kokanee in an age class, and multiplied by the population estimate of that age class to determine biomass. A detailed description of trawling methodology was presented in Rieman (1992).

Kokanee Ageing

Kokanee scales were removed from trawl-caught fish and impressed in clear plastic laminate sheeting using a Carver Model C laboratory press. We exerted 6 metric tons of force at a temperature of 70°C for approximately 10 s in making the impressions. Plastic impressions were then read on a microfiche reader by two individuals to resolve discrepancies.

Spawning Trends

Visual counts of kokanee spawners were made by walking selected tributaries of Dworshak Reservoir during the peak of the fall spawning run to obtain a relative index of kokanee spawner abundance. Streams surveyed included Isabella, Skull, Quartz, and Dog creeks. Surveys ran from the creek mouth upstream to the end of spawning run or to a migration barrier. Surveys were conducted on September 24, 1993.

Correlation Between Kokanee Abundance and Dam Discharge

We compared the abundance of different age classes of kokanee, as determined by trawling, to the amount of water discharged from Dworshak Dam during the previous 12 months. Total dam discharge from July 1 to June 30 was converted to mean daily discharge for our plots. We also compared kokanee abundance to dam discharge one year earlier, the mean daily discharge 24 months to 12 months before our trawling.

Least squares relationships and correlation coefficients were calculated using standard software programs.

Kokanee Size

Density dependant growth was examined by comparing the modal length of age 2 kokanee in July trawl samples to the abundance of the age 2 year class for the years 1988 to 1993. Data from 1990 was excluded since trawling was conducted in September. A line was fitted to the data set by least squares analysis using standard software.

RESULTS

Kokanee Abundance

We estimated total kokanee abundance in all age classes in 1993 at 1,163,000 fish (Table 1). Age 0 kokanee comprised 453,000 fish ± 29%. The most numerous age class was the age 1 fish. They were at the highest level we have ever recorded at 556,000 fish ± 22%. The age 2 year class was also relatively strong at 148,000 kokanee ± 15%. As typical of past years, only a very few age 3 kokanee were documented, 6,000 fish ± 83%. We estimated a density of 34 kokanee/hectare of a size that would be recruited to the fishery (the age 2 plus age 3 fish). Kokanee biomass was estimated at 12.9 kg/hectare, which is the highest we have recorded since trawling began in 1988 (Table 1).

Three sizes of kokanee were seen in the trawl catch (Figure 3). Peaks in the size-frequency distribution corresponded to the age classes of kokanee with ages 2 and 3 overlapping.

We also examined kokanee distribution throughout the reservoir by dividing the reservoir into three sections. The lower section of the reservoir, near Dworshak Dam, contained the lowest densities of fish of any age class (Table 2). The middle section of the reservoir contained the highest density of age 0 kokanee; and the highest densities of age 1 and age 2 kokanee were found above Grandad Bridge.

Table 1. Kokanee population estimates (thousands) in Dworshak Reservoir, Idaho, from 1988 to 1993.

Year Class[1] of kokanee	July 1993	July 1992	July 1991	September 1990	September 1989	Late June 1989	Early June 1989	July 1988
	Year Estimated							
1992	453							
1991	556	1,043						
1990	148	254	132					
1989	6	99	208	978				
1988			19	161	648	148	294	
1987			6	11[2]	165	148	100	553
1986				3[2]	45	175	140	501
1985							5	144
1984								12
Totals	1,163	1,396	365	1,153	858	471	539	1,210
Number/ hectare	254	305	68	214	159	87	100	224
Age 2+3/ hectare	34	21.5	4.6	2.6	8.3	32.4	26.9	28.9
Biomass (kg/hectare)	12.9	8.3	2.9	4.4	5.9	5.2		9.7

[1] Year class was defined as the year eggs were laid.
[2] Mature kokanee underestimated in September sampling.

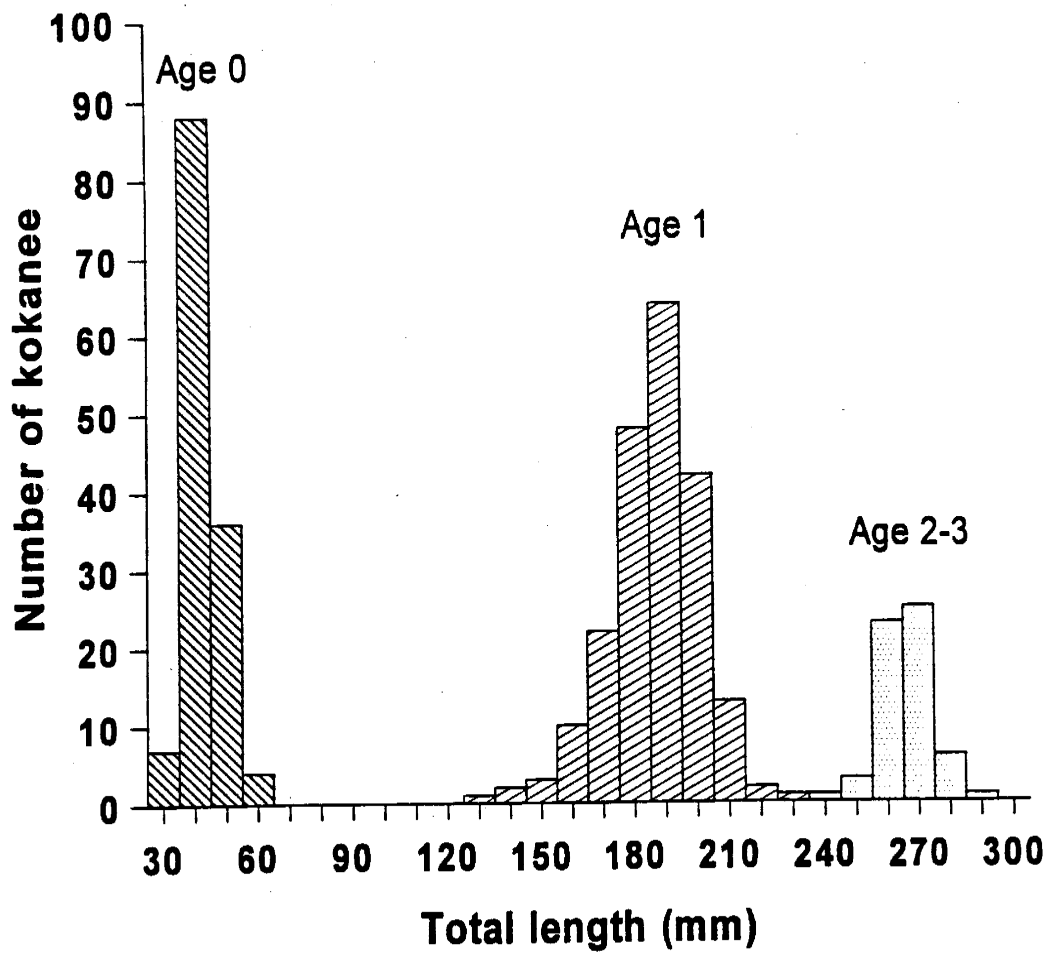

Figure 3. Length-frequency distribution of kokanee caught by mid-water trawl in Dworshak Reservoir, Idaho, July 27-30, 1993.

Table 2. Densities (number/hectare) of kokanee in each section of Dworshak Reservoir, Idaho, 1988-1993. Section 1 was from the dam to Dent Bridge, section 2 was from Dent Bridge to Grandad Bridge, and section 3 was from Grandad Bridge to the end of slack water.

	Densities				
	Age 0	Age 1	Age 2	Age 3	Total
July 19-22, 1993					
Section 1	23	81	22	0	126
Section 2	222	156	39	4	421
Section 3	119	223	65	0	407
July 27-30, 1992					
Section 1	5	31	17		53
Section 2	333	94	10		437
Section 3	1,018	64	79		1,161
July 8-12, 1991					
Section 1	28	50	6	2	86
Section 2	22	23	0	0	45
Section 3	17	27	3	0	47
September 17-20, 1990					
Section 1	143	14	2	0	159
Section 2	289	71	3	2	365
Section 3	345	35	0	0	380
September 25-28, 1989					
Section 1	135	38	21	0	194
Section 2	172	53	8	0	233
Section 3	144	17	0	0	161
June 27-30, 1989					
Section 1	6	42	34	0	82
Section 2	20	16	25	2	63
Section 3	147	0	22	0	169
July 11-14, 1988			Age 2+3		
Section 1	167	78	20		265
Section 2	49	96	17		162
Section 3	71	135	71		277

Survival Rates

Based on our trawling, we estimated a kokanee survival rate of 53% for last year's kokanee fry to this year's age 1 fish (Table 3). Similarly, last year's age 1 kokanee survived at a 58% rate to this year's age 2 kokanee. We estimated kokanee survival from age 2 to age 3 at 2%, which is not unusually low since most kokanee spawn and die at age 2.

Last year we estimated a potential egg deposition of 29,913,000 eggs. These emerged this spring into an estimated 453,000 fall fry for an egg to fry survival rate of 1.5% (Table 4).

Spawning Trends

We counted record high numbers of kokanee in our standardized spawner surveys in Isabella, Skull, and Quartz creeks. A total of 39,221 fish were counted, which was about double the previous high counts in 1988 (21,827 fish) and 1985 (21,000 fish) (Table 5). Isabella Creek had the highest count (29,171) followed by Skull Creek (7,574), Dog Creek (6,780), and Quartz Creek (2,476). The spawner count numbers were inflated by the presence of mature age 1 fish. This is the first year that we noted both male and female age 1 spawners in the spawning run (Figure 4). The modal size of age 1 and age 2 kokanee spawners was 235 mm and 285 mm, respectively.

These record high spawner counts were strongly correlated (r^2=0.89) to the high numbers of mature kokanee caught by trawling (Figure 5).

Kokanee length in the spawning run was inversely related to their abundance (r^2=0.75) (Figure 6). Unlike previous years, we saw numerous age 1 kokanee in the tributary streams which inflated the count data. This data point may be misleading if used to show density dependant growth.

Spawner count for 1993 was compared to mean daily discharge from July 1, 1991 to June 30, 1992 (Figure 7). This point was added to the previously constructed relationship in Maiolie and Elam (1993) to note the effect of discharge on kokanee abundance.

Potential Egg Deposition

About 9% of the age 1 kokanee were mature, which equates to 25,596 female fish containing an estimated 8,488,000 eggs (331 eggs/female). We assumed a 1:1 male to female ratio. Ninety-eight percent of the age 2 and age 3 kokanee were mature and averaged 285 mm in length. They contained an estimated 43,127,000 eggs at 570 eggs/female. We therefore estimated the total potential egg deposition at 51,615,000 eggs for 1993 (Table 4).

Correlations Between Kokanee Abundance and Dam Discharge

Abundance of age 2 kokanee was inversely correlated to the amount of water discharged from the dam during the previous 12 months (r^2=0.67) (Figure 8). Age 2 kokanee abundance was also negatively correlated to discharge during the interval 12 to 24 months before trawling (r^2=0.62) (Figure 9).

Table 3. Survival rates (%) for kokanee in Dworshak Reservoir, Idaho, 1989 to 1993, by age class.

Year of estimate	Age class		
	Age 0-1	Age 1-2	Age 2-3
1989	18	28	0
1990	55	11	-
1991	21	12	-
1992	192 [1]	41	0
1993	53	58	6
Mean	37	30	2

[1] In 1991, the age 0 year class was underestimated, this value not used in average.

Table 4. Potential egg deposition and survival rates of resulting fry in Dworshak Reservoir, Idaho, 1988-1993.

Year	Estimates: Female spawning escapement (x 1,000)	Potential egg deposition (x 1,000)[1]	Fry from previous years escapement (x 1,000)	Potential egg to fry survival (%)
1988	78	44,491	--	
1989	88	46,693	648	1.5
1990	--[2]	--	978	2.1
1991	13	7,933	--	--
1992	50	29,913	1,043	13.1
1993	102	51,615	453	1.5

[1] Calculated from the formula Y= 3.98x-544, where x=total length of females (mm) (Rieman 1992).
[2] September trawling too late in year to get a reliable estimate.

Table 5. Number of spawning kokanee observed in selected tributaries to Dworshak Reservoir, Idaho, 1981 to 1993.

Stream	Date Surveyed												
	9/81	9/82	9/83	9/84	9/85	9/87	11/87	9/88	9/89	9/90	9/91	9/92	9/93
Isabella	4,000	5,000	2,250	9,000	10,000	3,520	0	10,960	11,830	10,535	4,053	7,085	29,171
Skull	3,220	4,500	135	2,200	8,000	1,351	0	5,780	5,185	3,219	1,249	4,299	7,574
Quartz	850	1,076	66	1,000	2,000	1,477	0	5,080	2,970	1,702	693	1,808	2,476
Dog						700	0	1,720	1,720	1,875	590	1,120	6,780
Break-fast						23[1]		14,760[1]	14,402[1]	1,149[1]	3,557		
Beaver	2,117	4,000	384		8,000		0	1,700[1]	2,362[1]				
Elk							0	30[1]					
Total of Isabella, Skull, Quartz	8,070	10,576	2,451	12,200	21,000	6,348	0	21,827	19,985	15,456	5,995	13,192	39,221

[1] Surveys were not conducted to the end of the spawning run.

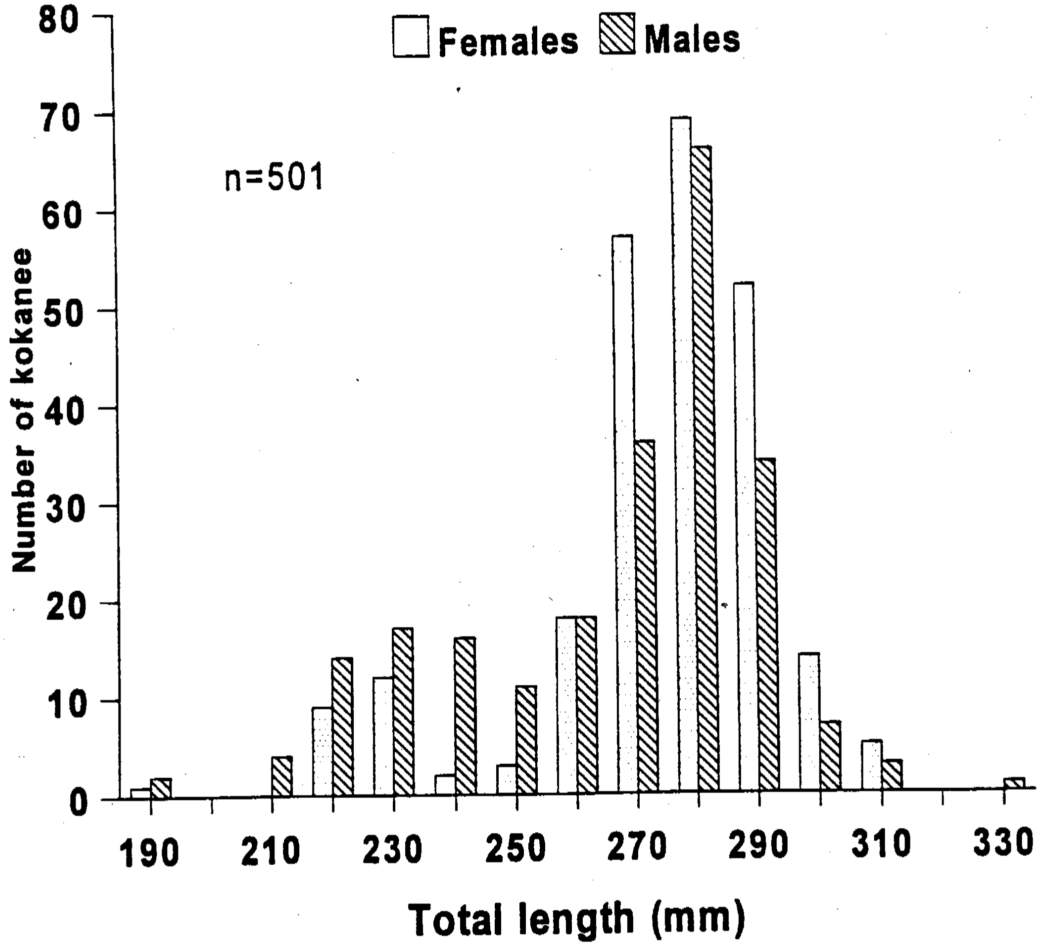

Figure 4. Total length and sex of kokanee spawners in Isabella, Skull, and Quartz creeks, tributaries to Dworshak Reservoir, September 1993.

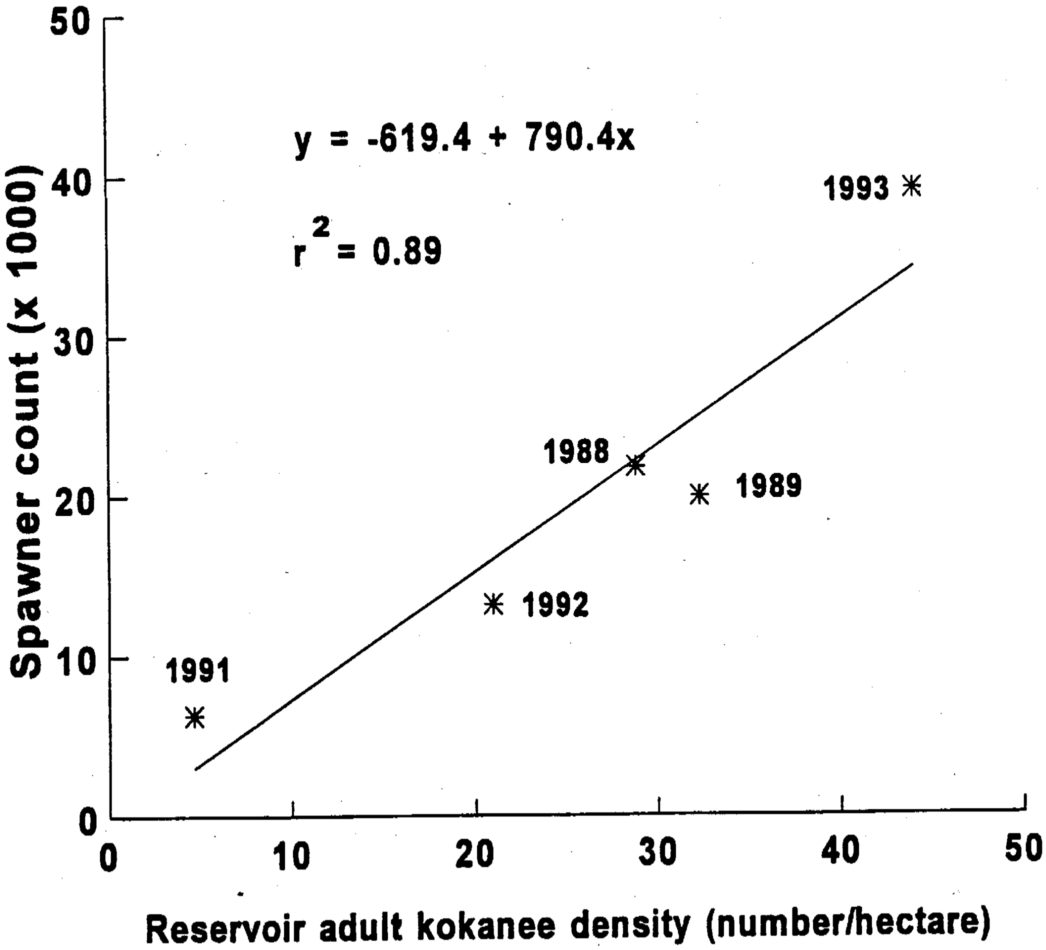

Figure 5. Relationship between the number of kokanee spawners in Isabella, Skull, and Quartz creeks and the number of mature kokanee determined by trawling Dworshak Reservoir, Idaho.

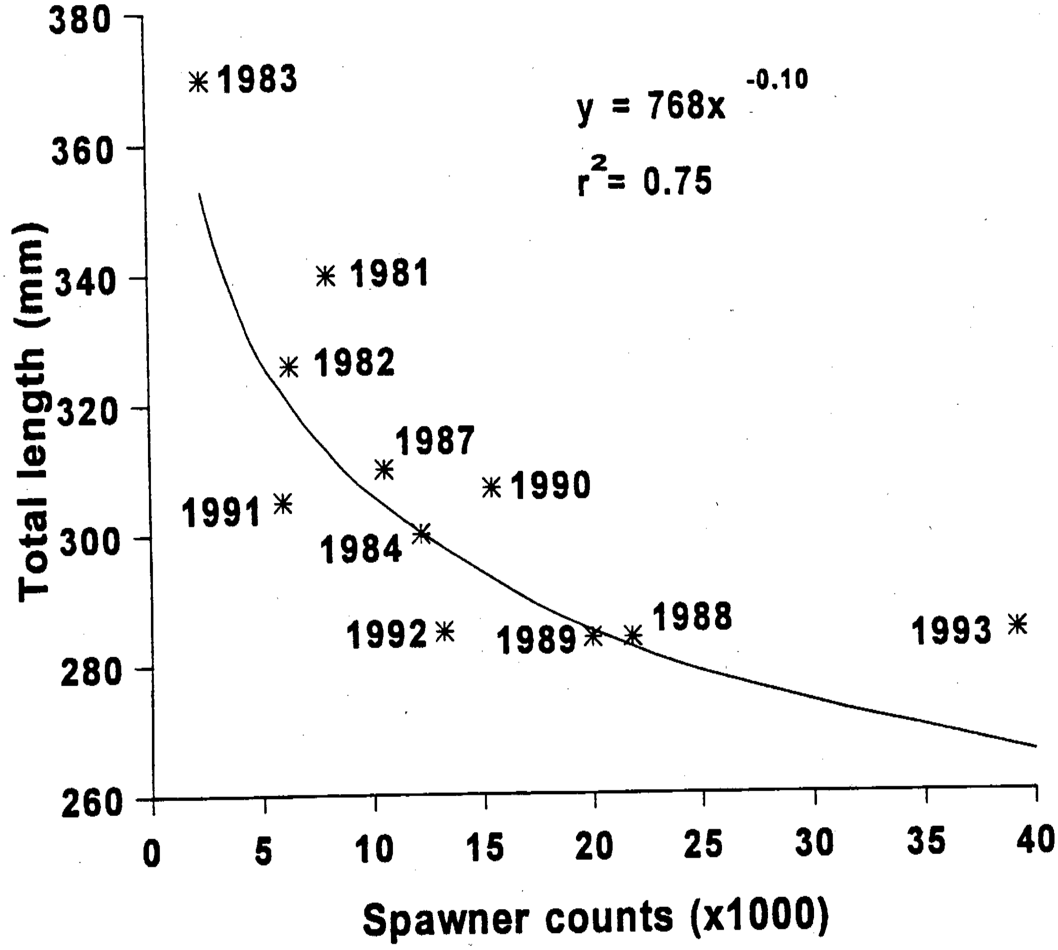

Figure 6. Number of kokanee spawners counted in Isabella, Quartz, and Skull creeks, tributaries to Dworshak Reservoir, Idaho, compared to the modal length of age 2 kokanee spawners. Spawner count for 1993 includes the presence of numerous age 1 kokanee spawners.

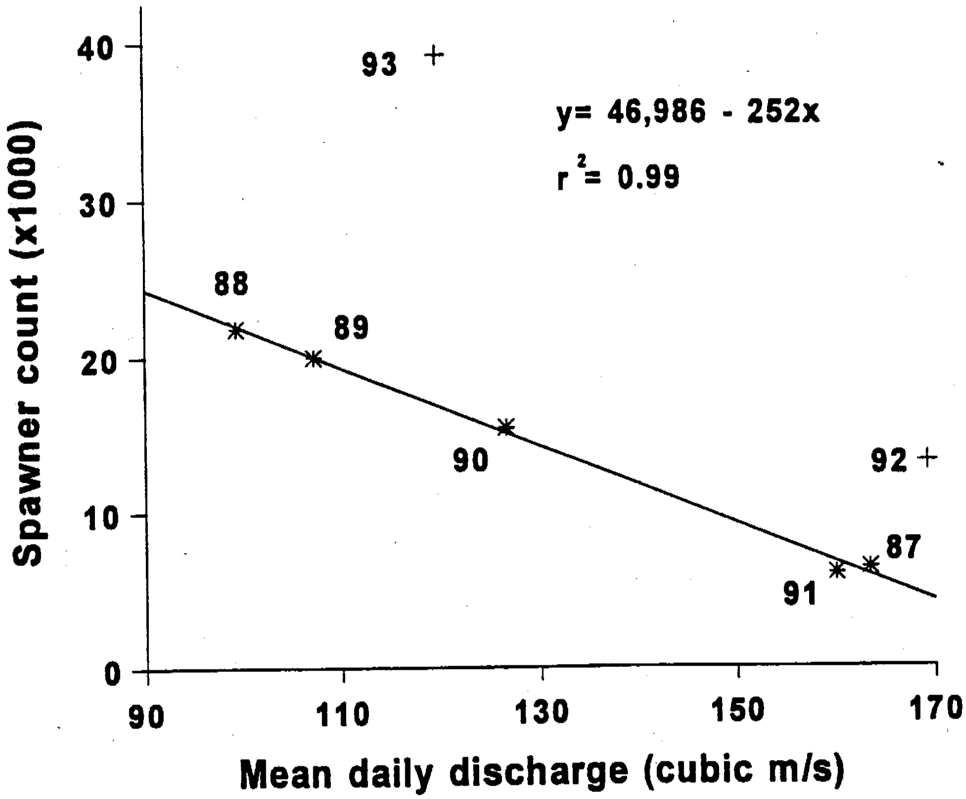

Figure 7. Relationship between the amount of water discharged from Dworshak Dam from July 1 to June 30 and the number of kokanee spawners the following year in Isabella, Quartz, and Skull Creeks. Equation refers to data collected in 1987 to 1991. Data from 1992 and 1993 were added for comparison.

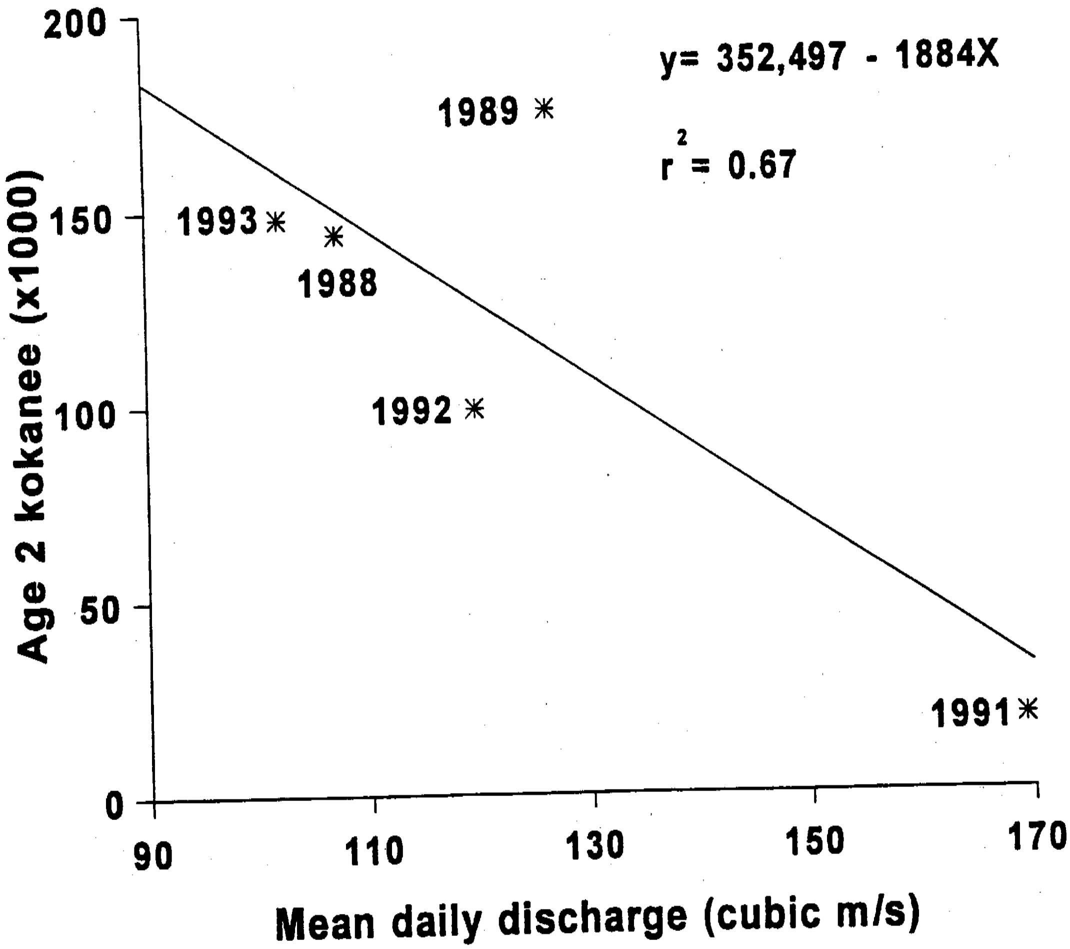

Figure 8. Relationship between the amount of water discharged from Dworshak Dam from July 1 to June 30 and the abundance of age 2 kokanee in the reservoir one year later.

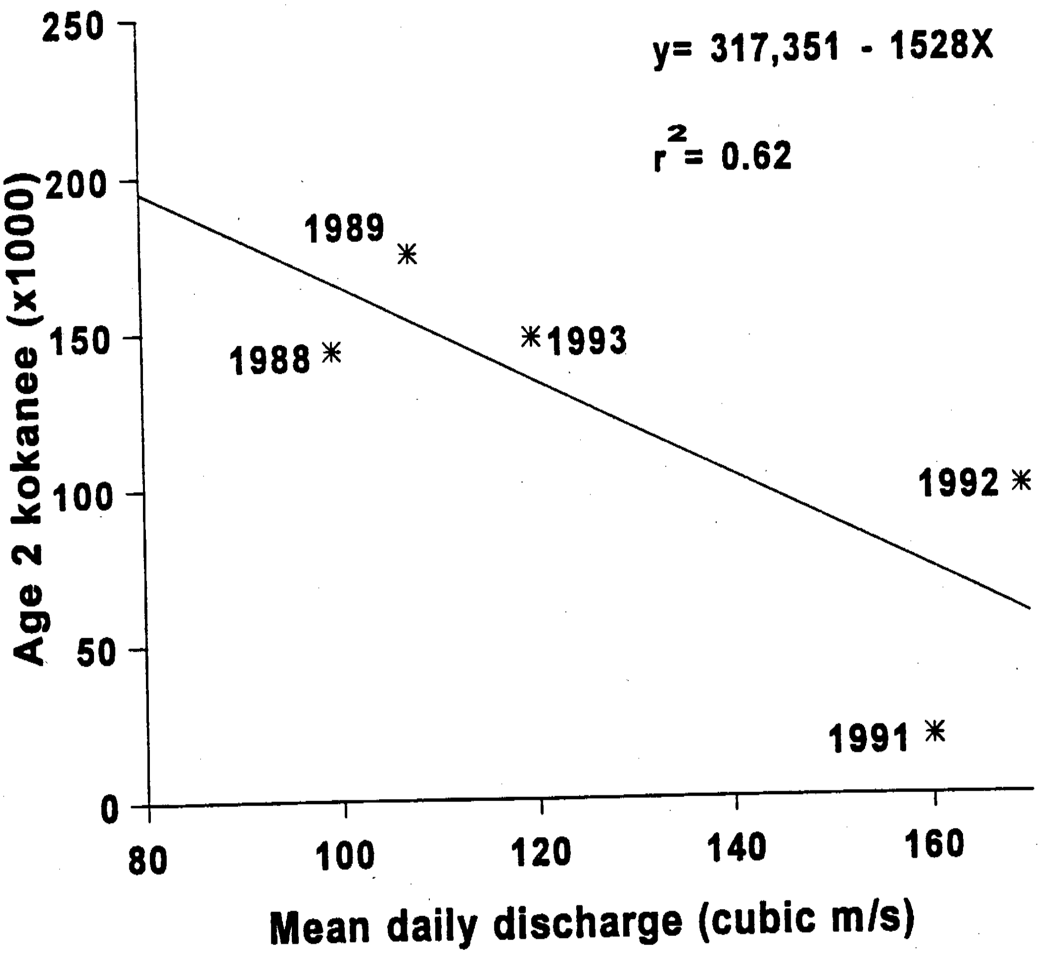

Figure 9. Relationship between the amount of water discharged from Dworshak Dam from July 1 to June 30 and the abundance of age 2 kokanee in the reservoir the same year.

Age 1 kokanee abundance was negatively correlated to mean daily discharge from the dam during the preceding 12 months (r^2=0.74) (Figure 10). Abundance of age 1 kokanee, however, was not well correlated to the dam discharge during the period from 24 months to 12 months previous to trawling (r^2=0.14) (Figure 11).

Kokanee Size

Density dependant growth was evident in kokanee year classes from Dworshak Reservoir (Figure 12). As age 2 kokanee abundance increased from 19,000 to 175,000 (an 821% increase in abundance), kokanee size declined from 280 mm to 245 mm (a decline in size of 12.5%). Correlation coefficient for a linear fit to the data set was r^2=0.57.

DISCUSSION

Kokanee Population Dynamics and Entrainment Losses

The Dworshak Reservoir kokanee population (and resulting fishery) is highly variable. The density of larger fish changed from 32 fish/hectare to 5 fish/hectare to 34 fish/hectare during the span of only four years (Table 1). Changes in fish density (as measured by spawner counts) were correlated (r^2=0.99, n=5) to the amount of water discharged through the dam during the 12-month period which ended one year before the spawner counts were made (Maiolie and Elam 1993). This finding led to the conclusion that entrainment losses of age 1 kokanee were the major determining factor affecting the density of adult kokanee and the resulting fishery (Maiolie and Elam 1993).

Spawner counts for 1992 and 1993 fell well above the previously graphed trend line which indicated the dam's operation was better for adult kokanee abundance than would have been expected (Figure 7). The presences of age 1 kokanee in the spawning run, however, affected the spawner counts making this data not comparable. Thus, we utilized another approach in evaluating the dams operation.

We constructed relationships between kokanee population densities obtained by trawling and the amount of water discharged through the dam (Figures 8 to 11). Abundance of age 2 kokanee in the reservoir versus mean daily discharge, with a one year lag time, were correlated; r^2=0.62 (Figure 9). In this relationship, 1993 appears to be "typical" for what would be expected during a drought year. Age 2 kokanee abundance was also correlated (r^2=0.67) to mean daily discharge with no lag time (Figure 8). Again, 1993 kokanee abundance was considered "typical" for the drought conditions.

Age 1 kokanee abundance was correlated (r^2=0.74) to mean daily discharge during the previous 12 months (Figure 10). Based on this trend, abundance of age 1 kokanee in 1993 was "as expected" considering the low water conditions. We found a poor correlation (r^2=0.14) between the abundance of age 1 kokanee and discharge with a one year lag time (Figure 11). This would indicate that entrainment of age 0 kokanee is not a significant problem. We did not expect age 0 kokanee entrainment would be significant since they were located mostly in the upper third of the reservoir, based on trawling results (Table 2).

We drew several conclusions from Figures 7 to 11. Spawner counts may be misleading when discussing kokanee year classes since they can include several age classes of fish (Figure 7). Secondly, low water years are correlated to low entrainment which affected the abundance of age 1 kokanee and thus the number of age 2 kokanee the following year (Figure 8 and 10). And lastly, annual discharge affected the abundance of age 2 kokanee in that year (Figure 9).

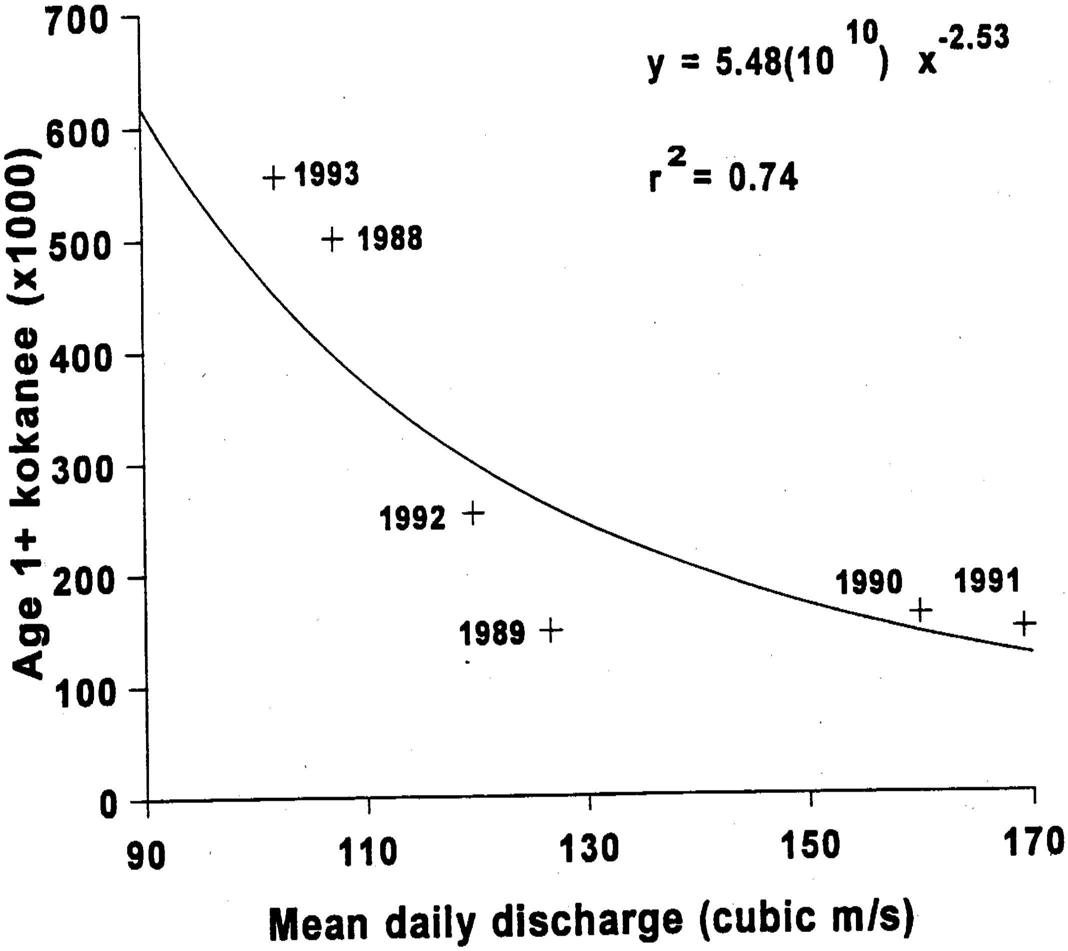

Figure 10. Relationship between the amount of water discharged from Dworshak Dam from July 1 to June 30 and the abundance of age 1 kokanee in the reservoir the same year.

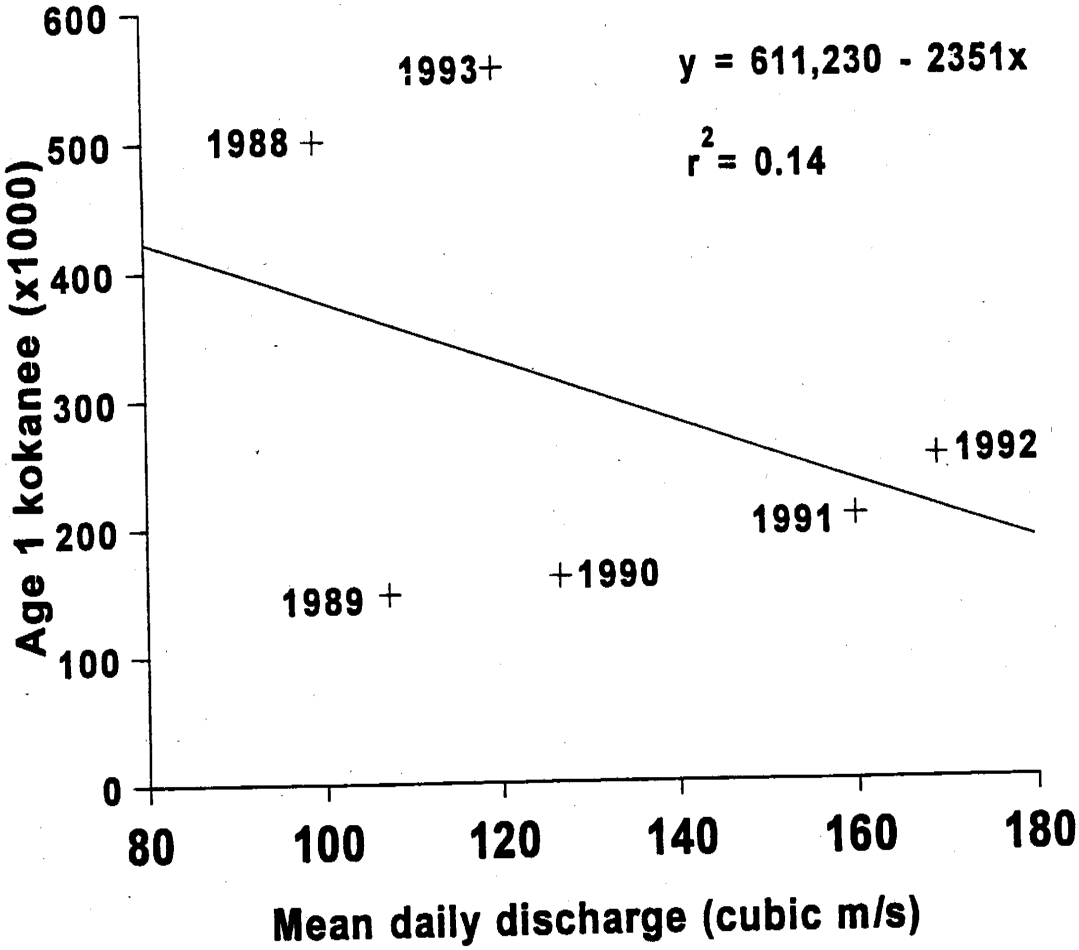

Figure 11. Relationship between the amount of water discharged from Dworshak Dam from July 1 to June 30 and the abundance of age 1 kokanee in the reservoir one year later.

Operation of Dworshak dam changed during 1992 (Figure 2). The reservoir peaked in May, but then was drafted between June and September for anadromous fish flows. This was the first time the reservoir elevation declined all summer. The entrainment losses of kokanee with this drawdown regime were no higher nor lower than we expected considering the amount of flow through the dam in the previous two years (Figures 8 to 11). Apparently, a drawdown in mid-summer for anadromous fish with low flows during the rest of the year did not trigger higher entrainment losses than the more customary fall drawdown.

Kokanee Size

Large kokanee in the fishery was one of the reasons for the popularity of Dworshak Reservoir. In most lakes in northern Idaho, kokanee average about 250 mm. Dworshak Reservoir kokanee have ranged from 280 to 370 mm in the spawning run in past years. The total length of kokanee has varied inversely with the abundance of kokanee (Figure 6). The extremely high spawning count in 1993 provides an interesting data point to study the effects of high density. Spawning run data may be misleading in 1993 since the increase in number of mature age 1 fish increased the spawner count. A better way to illustrate density dependant growth was to plot kokanee length in July trawl samples against density estimates of age 2 kokanee made by trawling (Figure 12).

Rieman and Meyers (1990) showed that density dependant growth can be expected across the entire range of kokanee densities, although not in a linear fashion. Data from Dworshak Reservoir kokanee is consistent with their model. As kokanee abundance increased from 19,000 fish to 148,000 fish, their modal size declined from 280 to 270 mm (Figure 12). This 8-fold change in abundance triggered a 4% decline in size. The higher abundance of kokanee should have improved catch rates, harvest, and fishing pressure on the reservoir, although no creel surveys were conducted. The 1989 spawning run contained the most, and smallest, kokanee on record. Although well below our modeled response, it clearly demonstrated that high kokanee abundance resulted in smaller fish. To date, managing for kokanee densities of 30 age 2 kokanee/hectare is an appropriate objective.

RECOMMENDATIONS

1. The relationships of discharge to age 1 and age 2 kokanee abundance should be included in any future modeling for the Systems Operation Review. This data should replace the current relationship based on spawner counts. These correlations are our best example of how dam operation affects the kokanee population.

2. Determine if high winter pool elevations (above 470-m elevation) will continue the recent trend towards high kokanee abundance even in wetter water years.

3. A more detailed approach to entrainment monitoring should be pursued. Fixed location hydroacoustic surveys on the dam and/or netting studies which determine when entrainment losses occur could be highly beneficial in isolating detrimental operating conditions.

4. The positioning of the dam's selector gates should be examined to determine if they can be used to minimize kokanee losses. The installation of entrainment monitoring gear within the dam would be helpful in evaluating selector gate settings.

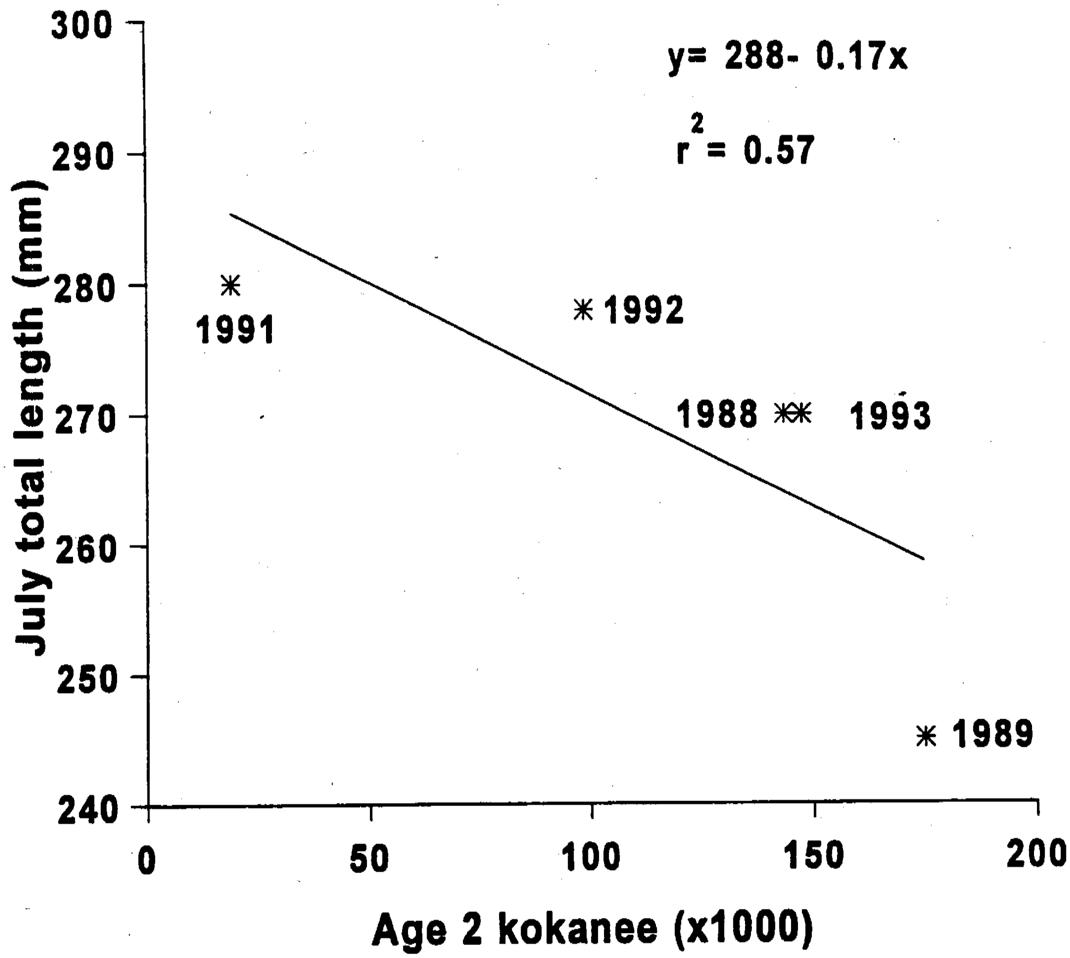

Figure 12. Relationship between age 2 kokanee density in Dworshak Reservoir, Idaho, and their total length. Data were based on trawl samples.

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CHAPTER 2

EXPERIMENTAL TRAWLING OF LAKE ROOSEVELT, WASHINGTON

ABSTRACT

In 1993, we mid-water trawled Lake Roosevelt (Grand Coulee Reservoir) to determine the feasibility of estimating kokanee oncorhynchus nerka kennerlyi densities. No kokanee were collected in 11 trawl hauls. We did, however, collect lake whitefish Coregonus clupeaformis, burbot Lota lota, and numerous sculpins (genus Cottus). Density of kokanee in the pelagic zone of Lake Roosevelt was too low for trawling to be effective for population estimates.

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ANNREP93

EXPERIMENTAL TRAWLING OF LAKE ROOSEVELT

INTRODUCTION

The Idaho Department of Fish and Game, in conjunction with the Spokane Tribe, trawled Lake Roosevelt, Washington, in the summer of 1993. We wanted to determine if trawling was a suitable method to estimate kokanee <u>Oncorhynchus nerka kennerlyi</u> densities in this reservoir. Trawling has been used in Idaho since 1977, and is an integral part of our kokanee management program. Abundance of each age class of kokanee can often be estimated to within $\pm$ 20 - 30% for the entire body of water (P=0.10). We have generated relationships between kokanee density and catch rate, harvest, and yield which can steer fishery management decisions in order to optimize kokanee fisheries (Rieman and Maiolie, in press). No density estimates or abundance estimates exist for the kokanee population in Lake Roosevelt. If the trawling methodology can be utilized, it could aid in our fundamental understanding of this kokanee population, help with determining the direction for future fishery management, assist with defining water level management strategies for the Systems Operation Review, and serve as a mechanism to evaluate the Tribe's kokanee stocking program.

OBJECTIVE

To determine if midwater trawling would be an effective method to estimate kokanee density in Lake Roosevelt.

METHODS

Kokanee Abundance

Oblique tows of a Hauser type mid-water trawl were used to obtain density estimates and representative samples of fish. An 8.5-m, 140-horsepower diesel engine boat towed the trawl net, which was 13.7-m long with a 3-m by 3-m mouth. Mesh sizes (stretch measure) graduated from 32 mm to 25 mm to 19 mm to 13 mm in the body of the net and terminated in a 6-mm mesh cod end. Rieman (1992) presented a detailed description of the methodology.

All trawling was conducted after dark during the new moon phase to optimize capture efficiency (Bowler et al. 1979). Net towing speed was standardized at 1.5 m/s. Depth of the net was determined for each 15.2-m distance of tow cable and checked annually. The general methodology involves determining the layer of kokanee distribution using a Raytheon Model V860 depth sounder with a 20-degree transducer. Typically, kokanee form a 10-m to 15-m wide band at a depth of 10 to 25-m. If no kokanee band can be detected (as was the case in Lake Roosevelt), then oblique tows would encompass the entire range possible. We therefore conducted step-wise oblique net tows from depths of 34.4-m (113 feet) to a minimum depth of 3.4-m (11 feet). Net was pulled for 3 min in each "step," sampling 2,832 m^3 of water over a distance of 315-m (at a boat speed of 1.5 m/s). The net was then raised 3-m and sampling continued for another 3 min. The time it took to readjust the net between steps and the time the net was sampling while initially setting the net was also entered into density estimates (approximately 30 seconds between steps while raising and lowering the net).

We conducted eight trawls from the buoys in front of Grand Coulee Dam upstream for a distance of 18 km (to river mile 608). Two more trawls were conducted in the Spokane Arm about 5 km and 8 km from the mouth. The last trawl was conducted in the main reservoir beginning at a point just north of the mouth of the Spokane Arm and continued in a southerly direction for 3 km.

The specific depth of each haul is listed in Appendix A.

RESULTS

No kokanee were collected in any of the 11 trawls. In the main reservoir, extremely few fish were seen on the echosounder in the pelagic zone. In the Spokane Arm, a layer of fish was seen on the echosounder near the bottom in 27-m to 35-m of water inside the old river channel. Subsequent trawls in this area collected three lake whitefish Coregonus clupeaformis up to 596 mm in length (Figure 1; Appendix A). The density estimate of whitefish in the Spokane Arm was 15 whitefish/hectare.

In nearly every trawl sample, however, numerous small sculpins (genus Cottus) from 17 mm to 37 mm were collected (Figure 1; Appendix A). Density of sculpins in our trawl samples was 66 sculpins/hectare in the lower end of the reservoir, 56 sculpins/hectare in the Spokane Arm, and 101 sculpins/hectare in the Seven Bays area.

We also netted one 85 mm burbot Lota lota in the Spokane Arm while sampling 5.16 hectares of water (Figure 1; Appendix A).

DISCUSSION

Density of kokanee in the pelagic zone of Lake Roosevelt during mid-summer was too low to make trawling an effective means of conducting population estimates. Eleven trawls without catching any kokanee, and very few fish seen on the echosounder, support this finding. It is possible, however, that trawling may be effective at other locations, or other times of the year.

This finding presents an additional question as to why kokanee densities would be so low. Kokanee have been stocked into Lake Roosevelt since 1986, and the Tribe maintains and operates two kokanee hatcheries on the reservoir. Yet, not even small kokanee were collected. Temperature profiles made by the Spokane Tribe during August documented >16°C water temperatures above 33-m (the maximum depth sampled). Kokanee are thought to seek 11°C water at night to aid in food digestion. Possibly kokanee were in areas of cooler water, although it is unknown where that might be. No kokanee layer was seen on the echosounder, even at depths to 100-m. If kokanee densities are as low as we anticipate, it may indicate very high entrainment losses through Grand Coulee Dam. Entrainment losses may be exacerbated by the somewhat warm temperatures of the reservoir and its low retention time. The low densities of kokanee could also be caused by high predation, low survival of hatchery stocks, or numerous other reasons, but these would be speculation at this time.

Density estimates of burbot, whitefish, and sculpins should be viewed with caution. These non-target species were caught incidentally while using a method designed for kokanee. Our sampling was not a randomized approach at sampling their habitat. Also, the low number of samples and low numbers of fish caught makes these estimates of questionable accuracy.

We were somewhat surprised by the high density of sculpins in the water column. In sampling five other lakes over a period of six years, we have never seen a sculpin in the trawl catch. These sculpins could not be identified because of the difficulty in counting lateral line pores on such small fish.

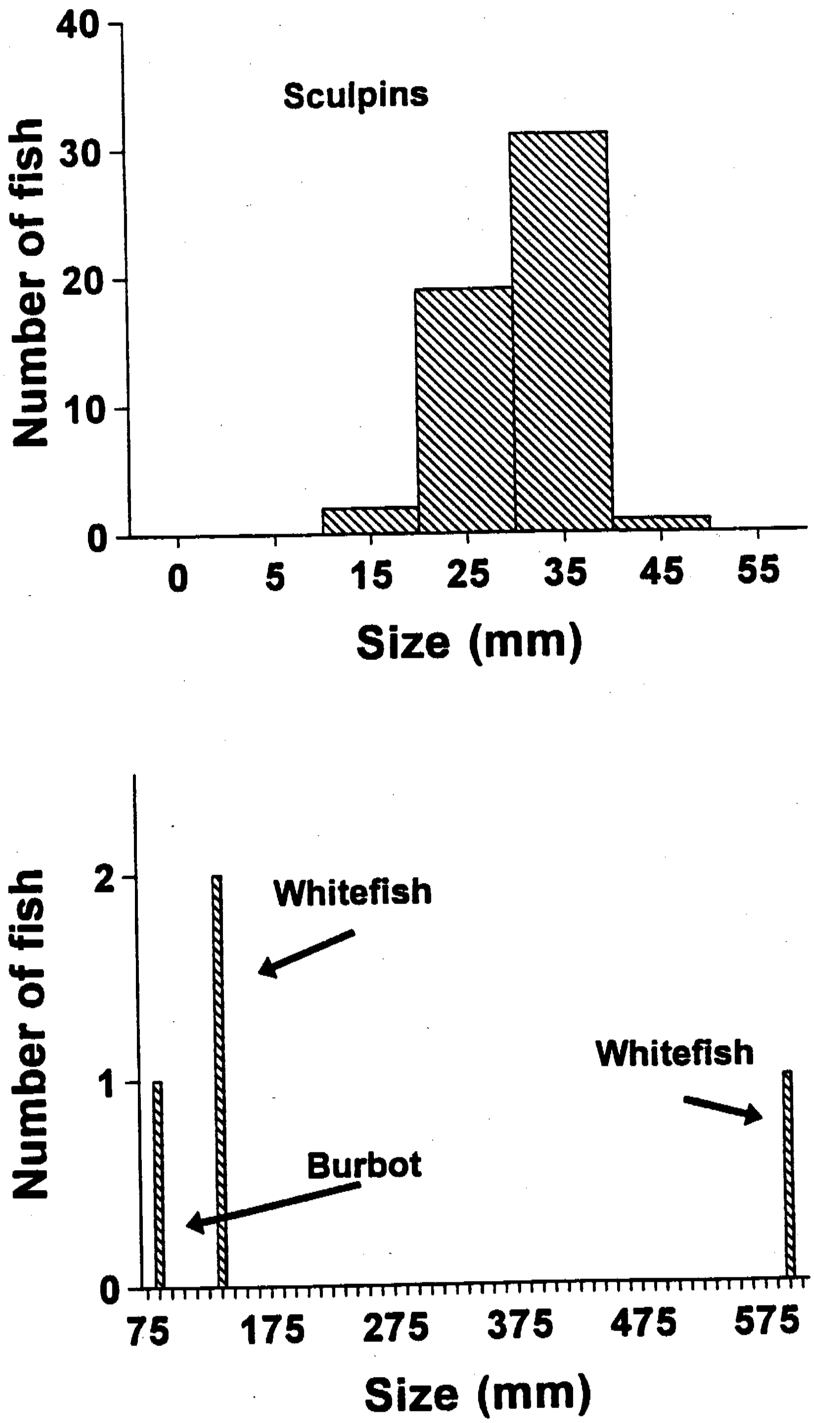

Figure 1. Lengths of sculpins (top), burbot and lake whitefish (bottom) caught in Lake Roosevelt, Washington, August 1993.

CONCLUSION

Densities of kokanee in Lake Roosevelt appear to be too low for their collection by mid-water trawling. Possibly kokanee were missed because they were too deep, or they were in other areas of the reservoir. It is, however, likely that their densities are very low. We speculate that warm water temperatures, the lack of stratification, and the low retention time, may result in high entrainment losses and a low population.

High sculpin densities were documented in the open water of the reservoir. Substantial numbers of lake whitefish were found near the bottom in the Spokane Arm of the reservoir.

RECOMMENDATIONS

1. We would not recommend that the Spokane Tribe invest the tens of thousands of dollars needed to build a mid-water trawler to monitor kokanee abundance.
2. We would recommend that another means, such as hydroacoustics in conjunction with netting, be explored to monitor fish abundance.
3. Lastly, Lake Roosevelt should be examined to determine why kokanee densities are so low even with its vigorous hatchery program.

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A P P E N D I C E S

Appendix A. Trawling depths, times, and type of fish caught while sampling Lake Roosevelt, Washington, August 1993.

Trawl Number	Reservoir Section[a]	Maximum depth (m)	Minimum depth (m)	Number of steps	Time/ step (s)	Time between steps (s)	Boat speed (m/s)	Net mouth area (m^2)	Number of sculpins	Number of whitefish	Number of burbot
1	1	12.8	3.1	4	180	36	1.5	9.3	0	0	0
2	1	27.1	9.8	5	180	36	1.5	9.3	5	0	0
3	1	12.8	3.1	4	180	35	1.5	9.3	4	0	0
4	1	27.1	9.8	5	180	37	1.5	9.3	14	0	0
5	1	12.8	1.0	4	180	34	1.5	9.3	1	0	0
6	1	30.8	17.1	4	180	40	1.5	9.3	7	0	0
7	1	30.8	6.4	7	180	37	1.5	9.3	4	0	0
8	1	12.8	3.1	4	180	34	1.5	9.3	23	0	0
9	2	34.1	24.1	3	180	40	1.5	9.3	5	2	1
10	2	34.4	27.7	2	180	40	1.5	9.3	7	1	0
11	3	27.1	6.4	6	180	39	1.5	9.3	10	0	0

[a] Section 1 was the lower reservoir, section 2 was the Spokane Arm, section 3 was the Seven Bays area.

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